

US009068562B1

(12) United States Patent

Budica et al.

(10) Patent No.: US 9,068,562 B1

(45) **Date of Patent: Jun. 30, 2015**

(54) LASER-POWERED PROPULSION SYSTEM

(71) Applicant: **The Boeing Company**, Chicago, IL

(72) Inventors: **Robert J. Budica**, Laguna Hills, CA (US); **James S. Herzberg**, Long Beach,

(US); James S. Herzberg, Long Beach CA (US); Frank O. Chandler, Huntington Beach, CA (US)

(73) Assignee: The Boeing Company, Chicago, IL

(US)

(*) Notice: Subject to any disclaimer, the term of this

patent is extended or adjusted under 35 U.S.C. 154(b) by 396 days.

(21) Appl. No.: 13/645,816

(22) Filed: Oct. 5, 2012

(51) Int. Cl.

B64G 1/40 (2006.01)

F03H 1/00 (2006.01)

G21B 1/01 (2006.01)

G21B 1/03 (2006.01)

G21B 1/15 (2006.01)

(52) U.S. Cl.

CPC **F03H 1/00** (2013.01); **B64G 1/408** (2013.01); G21B 1/01 (2013.01); G21B 1/03 (2013.01); G21B 1/15 (2013.01)

(58) Field of Classification Search

(56) References Cited

U.S. PATENT DOCUMENTS

4,297,165 A * 4,328,070 A *		Breuckner Friedwardt M.	376/103
5,542,247 A *	8/1996	Winterberg Bushman	

OTHER PUBLICATIONS

Orth "VISTA—A Vehicle for Interplanetary Space Transport Application Powered by Inertial Confinement Fusion", May 16, 2003, pp. 8, 18, 32, 42.*

Clark "Plastic ablator ignition capsule design for the National Ignition Facility" Journal of Physics: Conference Series 244 (2010), pp. 1-2.*

Fan "Diode Pumped Solid State Lasers" vol. 3, No. 3, 1990 The Lincoln Laboratory Journal, pp. 413,416.*

Hooper "Laser Plasma Interactions 5: Inertial Confinement Fusion" 1995 Taylor Francis Group, pp. 71-72.*

NASA—National Aeronautics and Space Administration; Specific Impulse; Glen Research Center; "Propulsion Device"; Article Editor: Tom Benson (NASA Official); Last Updated Jul. 11, 2008.

* cited by examiner

Primary Examiner — Phutthiwat Wongwian Assistant Examiner — William Breazeal

(57) ABSTRACT

A propulsion apparatus includes a propellant, at least one laser, and a thrust member. The propellant includes a solid surface having a hollow core disposed within the solid surface and a thrust-producing medium disposed within the hollow core. The at least one laser is positioned to vaporize the propellant with at least one laser-beam into a thrust-producing flow. The thrust member is for flowing within the thrust member a thrust-producing flow created by vaporization of the propellant.

29 Claims, 4 Drawing Sheets

